

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

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PATENT  
Docket: CU-5982

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### Amendments to the Claims

The listing of claims presented below replaces all prior versions, and listings, of claims in the application.

### Listing of claims:

1. (currently amended) A volume hologram recording photosensitive composition, comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a binder resin and a sensitizing dye which gets transparent by light-exposure or treatment after the light-exposure:

Formula (1)



wherein each  $R^1$  and  $R^2$  in the formula (1) is independently an epoxy group or an oxetanyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, [[and]]  $n$  is an integer of 1 or more; and

wherein the fluorine-containing photoreactive compound is the only fluorine-containing photoreactive compound represented by the formula (1).

2-4. (cancelled)

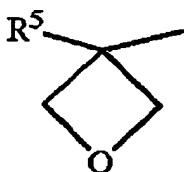
5. (previously presented) The volume hologram recording photosensitive composition according to claim 1, wherein each of  $R^1$  and  $R^2$  is an epoxy group.

6. (previously presented) The volume hologram recording photosensitive composition according to claim 1, wherein each of  $R^1$  and  $R^2$  in the formula (1) is an oxetanyl group represented by the following formula (2):

Formula (2)

Application Serial No. 10/615,041  
 Reply to Office Action of March 4, 2009

PATENT  
 Docket: CU-5982



wherein  $R^5$  is a hydrogen atom or an alkyl group having 1 to 10 carbon atoms.

7. (original) The volume hologram recording photosensitive composition according to claim 1, wherein each of  $R^3$  and  $R^4$  in the formula (1) is independently a single bond or a linear hydrocarbon group.

8. (original) The volume hologram recording photosensitive composition according to claim 1, which further comprises a photopolymerization initiator.

9. (cancelled)

10. (currently amended) The volume hologram recording photosensitive composition according to claim 1, wherein the binder resin comprises ~~at least one selected from the group consisting of a thermoplastic resin, a thermosetting resin, an organic-inorganic hybrid polymer, and an organic metal compound represented by the formula (4):~~

~~Formula (4)~~



~~wherein  $M'$  represents a metal such as Ti, Zr, Zn, In, Sn, Al or Se, and  $R''$  represents an alkyl group having 1 to 10 carbon atoms, and  $n'$  is the valence number of the metal  $M'$ .~~

11. (currently amended) The volume hologram recording photosensitive composition according to claim 1, which further comprises a second refractive index modulating component other than the ~~fluorine-contained~~ fluorine-containing

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

photoreactive compound.

12. (currently amended) The volume hologram recording photosensitive composition according to claim 11, wherein a combination of ingredients for forming a refractive index difference is any one selected from the group consisting of the following (1) to (4):

(1) a combination comprising the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1), a binder resin having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound, and a radical photopolymerizable compound which is the second refractive index modulating component having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound;

(2) a combination comprising the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1), a binder resin having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound, and a cationic photopolymerizable compound which is the second refractive index modulating component having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound;

(3) a combination comprising the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1), and two or more radical photopolymerizable compounds which are the second refractive index modulating components each having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound; and

(4) a combination comprising the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1), a radical photopolymerizable compound which is the second refractive index modulating component having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound, and a cationic photopolymerizable compound which is the second refractive index modulating component having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound.

13. (currently amended) The volume hologram recording photosensitive

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

composition according to claim 1, which further comprises metal fine particles having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1).

14. (cancelled)

15. (currently amended) The volume hologram recording photosensitive composition according to claim 1, wherein the sensitizing dye is at least one selected from the group consisting of cyanine type dyes, merocyanine type dyes, ~~coumalin~~ coumarin type dyes, ~~ketocoumalin~~ ketocoumarin type dyes, and cyclopentanone type dyes.

16. (currently amended) A volume hologram recording photosensitive medium, having a hologram recording section made of a volume hologram recording photosensitive composition comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a binder resin and a sensitizing dye which gets transparent by light-exposure or treatment after the light-exposure:

Formula (1)



wherein  $R^1$  and  $R^2$  in the formula (1) is independently an epoxy group or an oxetanyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, ~~[[and]]~~  $n$  is an integer of 1 or more; and

wherein the fluorine-containing photoreactive compound is the only fluorine-containing photoreactive compound represented by the formula (1).

17. (currently amended) A volume hologram having a hologram layer, wherein the hologram layer is formed by exposing, to light, a volume hologram recording photosensitive medium having a hologram recording section made of a volume

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

hologram recording photosensitive composition comprising a ~~fluorine-contained~~  
fluorine-containing photoreactive compound represented by the following formula (1),  
a binder resin and a sensitizing dye which gets transparent by light-exposure or  
treatment after the light-exposure:

Formula (1)



wherein  $R^1$  and  $R^2$  in the formula (1) is independently an epoxy group or an oxetanyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, [[and]]  $n$  is an integer of 1 or more, at the hologram recording section, [[and]]

wherein the hologram layer has 0.016 or more of refractive index modulation ( $\Delta n$ ) between its low refractive index region and its high refractive index region; and  
wherein the fluorine-containing photoreactive compound is the only fluorine-containing photoreactive compound represented by the formula (1).

18. (currently amended) A volume hologram recording photosensitive composition, comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a binder resin and metal fine particles having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1):

Formula (1)



wherein  $R^1$  and  $R^2$  in the formula (1) is independently an acryloyl group or a methacryloyl group and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and  $n$  is an integer of 1 or more.

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

19. (previously presented) The volume hologram recording photosensitive composition according to claim 18, which further comprises a photopolymerization initiator.

20. (cancelled)

21. (previously presented) The volume hologram recording photosensitive composition according to claim 20, wherein the binder resin comprises at least one selected from the group consisting of a thermoplastic resin, a thermosetting resin, an organic-inorganic hybrid polymer, and an organic metal compound represented by the formula (4):

Formula (4)



wherein M' represents a metal such as Ti, Zr, Zn, In, Sn, Al or Se, and R'' represents an alkyl group having 1 to 10 carbon atoms, and n' is the valence number of the metal M'.

22. (currently amended) The volume hologram recording photosensitive composition according to claim 18, which further comprises a sensitizing dye which is at least one member selected from the group consisting of cyanine type dyes, merocyanine type dyes, ~~coumalin~~ coumarin type dyes, ~~ketocoumalin~~ ketocoumarin type dyes, and cyclopentanone type dyes.

23. (currently amended) A volume hologram recording photosensitive medium, having a hologram recording section made of a volume hologram recording photosensitive composition comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a binder resin and metal fine particles having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1):

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

Formula (1)



wherein each  $R^1$  and  $R^2$  in the formula (1) is independently an acryloyl group or a methacryloyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and  $n$  is an integer of 1 or more.

24. (currently amended) A volume hologram having a hologram layer, wherein the hologram layer is formed by exposing, to light, a volume hologram recording photosensitive medium having a hologram recording section made of a volume hologram recording photosensitive composition comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a binder resin and metal fine particles having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1):

Formula (1)



wherein each  $R^1$  and  $R^2$  in the formula (1) is independently an acryloyl group or a methacryloyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and  $n$  is an integer of 1 or more, at the hologram recording section, and

wherein the hologram layer has 0.016 or more of refractive index modulation ( $\Delta n$ ) between its low refractive index region and its high refractive index region.

25. – 29. (cancelled)

30. (currently amended) The volume hologram recording photosensitive

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

composition according to claim 1, which further comprises a fluorine skeleton-containing ~~skeleton-contained~~ radical photopolymerizable compound having a refractive index different from that of the ~~fluorine-contained~~ fluorine-containing photosensitive compound represented by the formula (1) ~~or sulfur-contained radical photopolymerizable compound having a refractive index different from that of the fluorine-contained photosensitive compound represented by the formula (1).~~

31. (previously presented) The volume hologram recording photosensitive composition according to claim 1, wherein the sensitizing dye is 3-ethyl-5-[(3-ethyl-2(3H)-benzothiazolilidene)ethylidene]-2-thioxo-4-oxazolidinone.

32. (currently amended) A volume hologram recording photosensitive composition, comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a photopolymerization initiator and, as a sensitizing dye, 3-ethyl-5-[(3-ethyl-2(3H)-benzothiazolilidene)ethylidene]-2-thioxo-4-oxazolidinone:

Formula (1):



wherein each  $R^1$  and  $R^2$  in the formula (1) is independently an acryloyl group or a methacryloyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and  $n$  is an integer of 1 or more.

33. (previously presented) The volume hologram recording photosensitive composition according to claim 32, which further comprises a binder resin.

34. (previously presented) The volume hologram recording photosensitive composition according to claim 33, wherein the binder resin comprises at least one selected from the group consisting of a thermoplastic resin, a thermosetting resin, an organic-inorganic hybrid polymer and an organic metal compound represented by the formula (4):

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

Formula (4):



wherein M' represents a metal such as Ti, Zr, Zn, In, Sn, Al or Se, and R'' represents an alkyl group having 1 to 10 carbon atoms, and n' is the valence number of the metal M'.

35. (currently amended) The volume hologram recording photosensitive composition according to claim 32, which further comprises a cationic photopolymerizable compound which is a second refractive index modulating component other than the ~~fluorine-contained~~ fluorine-containing photoreactive compound.

36. (previously presented) The volume hologram recording photosensitive composition according to claim 32, wherein the cationic photopolymerizable compound has a fluorene skeleton.

37. (currently amended) A volume hologram recording photosensitive medium, having a hologram recording section made of a volume hologram recording photosensitive composition comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a photopolymerization initiator and, as a sensitizing dye, 3-ethyl-5-[(3-ethyl-2(3H)-benzothiazolilidene)ethylidene]-2-thioxo-4-oxazolidinone:

Formula (1):



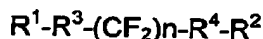
wherein each of R<sup>1</sup> and R<sup>2</sup> in the formula (1) is independently an acryloyl group or a methacryloyl group, and each of R<sup>3</sup> and R<sup>4</sup> is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and n is an integer of 1 or more.

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

38. (currently amended) A volume hologram having a hologram layer, wherein the hologram layer is formed by exposing to light, a volume hologram recording photosensitive medium having a hologram recording section made of a volume hologram recording photosensitive composition comprising a ~~fluorine-contained~~ fluorine-containing photoreactive compound represented by the following formula (1), a photopolymerization initiator and, as a sensitizing dye, 3-ethyl-5-[(3-ethyl-2(3H)-benzothiazolilidene)ethylidene]-2-thioxo-4-oxazolidinone:

Formula (1):

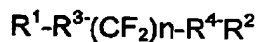


wherein each of  $R^1$  and  $R^2$  in the formula (1) is independently an acryloyl group or a methacryloyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms and  $n$  is an integer of 1 or more, at the hologram recording section, and

wherein the hologram layer has 0.016 or more of refractive index modulation ( $\Delta n$ ) between its low refractive index region and its high refractive index region.

39. (New) A volume hologram recording photosensitive composition, comprising a fluorine-containing photoreactive compound represented by the following formula (1), a fluorene skeleton-containing cationic photopolymerizable compound, a binder resin having an ethylenically unsaturated bond capable of causing additional polymerization:

Formula (1):



wherein each of  $R^1$  and  $R^2$  in the formula (1) is independently an acryloyl group or a methacryloyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and  $n$  is an integer of 1 or more.

40. (New) The volume hologram recording photosensitive composition according

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

to claim 39, wherein 10 to 1000 parts by weight of a fluorine-containing photoreactive compound represented by formula (1) is contained with respect to 100 parts by weight of the binder resin.

41. (New) A volume hologram recording photosensitive medium having a hologram recording section made of the volume hologram recording photosensitive composition defined by claim 39.

42. (New) A volume hologram having a hologram layer, wherein the hologram layer is formed by exposing, to light, the volume hologram recording photosensitive medium having the hologram recording section defined by claim 41 and the hologram layer has 0.016 or more of refractive index modulation ( $\Delta n$ ) between its low refractive index region and its high refractive index region.

43. (New) A volume hologram recording photosensitive composition, comprising a fluorine-containing photoreactive compound represented by the following formula (1), a binder resin, and metal fine particles having a refractive index different from that of the fluorine-containing photosensitive compound represented by the formula (1) and having an ethylenically unsaturated bond:

Formula (1):



wherein each of  $R^1$  and  $R^2$  in the formula (1) is independently an epoxy group, an oxetanyl group, an acryloyl group or a methacryloyl group, and each of  $R^3$  and  $R^4$  is independently a single bond or a bivalent hydrocarbon group having 1 to 5 carbon atoms, and  $n$  is an integer of 1 or more.

44. (New) The volume hologram recording photosensitive composition according to claim 43, which further comprises a photopolymerization initiator.

45. (New) The volume hologram recording photosensitive composition according to claim 43, wherein the binder resin comprises at least one selected from the group

Application Serial No. 10/615,041  
Reply to Office Action of March 4, 2009

PATENT  
Docket: CU-5982

consisting of a thermoplastic resin, a thermosetting resin, an organic-inorganic hybrid polymer, and an organic metal compound represented by the formula (4):

Formula (4):



Wherein M' represents a metal such as Ti, Zr, Zn, In, Sn, Al or Se, R<sup>n</sup> represents an alkyl group having 1 to 10 carbon atoms, and n' is the valence number of the metal M'.

46. (New) The volume hologram recording photosensitive composition according to claim 43, further comprising a sensitizing dye which is at least one selected from the group consisting of cyanine type dyes, merocyanine type dyes, coumarin type dyes, ketocoumarin type dyes, and cyclopentanone type dyes.

47. (New) A volume hologram recording photosensitive medium having a hologram recording section made of the volume hologram recording photosensitive composition defined by claim 43.

48. (New) A volume hologram having a hologram layer, wherein the hologram layer is formed by exposing, to light, the volume hologram recording photosensitive medium having the hologram recording section defined by claim 47 and the hologram layer has 0.016 or more of refractive index modulation ( $\Delta n$ ) between its low refractive index and its high refractive index region.